1990

Spatial manipulation as a covariant of mental practice

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Portland State University

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This experiment examined the relationship between a subject's ability to manipulate spatial relationships and utilize mental practice in the mirror drawing ability of 45 naive volunteer college students, using a six-pointed star track. The spatial manipulation abilities of all subjects were assessed with the Minnesota Paper Form Board Test, after which the subjects were divided into three treatment groups (no practice, mental practice, and physical practice) of 15 subjects using a blocked random design based upon their MPFBT scores. All three groups were trained in the mirror drawing task and
given three physical practice pre-trials for familiarization. The physical practice group (PP) was given six, 80-second physical practice trials with a 40-second interpolated rest/reading period during which they read from a standardized poetry text. The mental practice group (MP) was given six, 80-second mental practice trials with the same 40-second interpolated rest/reading period, and the no practice group (NP) was allowed to read from the standardized text for an equal amount of time. Following administration of the treatment conditions, all subjects were given three physical practice post-trials in the mirror drawing task. The mean of pre-trials two and three were subtracted from the mean of the three post-trials to obtain an improvement score. The subjects' scores on the MPFBT were compared to their improvement scores using the Spearman Rank-Order Correlation (rho) test, but there was no significant correlation between the two abilities.

By tabling the data to reflect three blocks of MPFBT scores (low, medium, high) for three practice conditions (NP, MP, and PP) and two trials (pre-trial and post-trial), the resultant 18 cells were compared using a three factor analysis of variance and repeated measures on one factor (trials). The three factor ANOVA demonstrated a significant difference between trials at the 0.001 alpha level and a difference between MPFBT blocks at the 0.05 alpha level. No significant interactions between the three factors were revealed above the 0.20 alpha level.

Since the task performance of subjects in the mental practice group did not differ significantly from subjects in the no practice group, this experiment disallows any meaningful conclusions to be drawn about the nature of the relationship between mental practice and the subject's spatial manipulations ability.
SPATIAL MANIPULATION AS A COVARIANT OF MENTAL PRACTICE

by

VINCENT JAMES WOLFF

A thesis submitted in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE in
PSYCHOLOGY

Portland State University
1990
TO THE OFFICE OF GRADUATE STUDIES:

The members of the Committee approve the thesis of Vincent James Wolff presented April 24, 1990.

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C. William Savery, Interim Vice Provost for Graduate Studies and Research
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CHAPTER I

INTRODUCTION

The belief among psychologists that thought mediates action can be traced back to the influence of James's ideo-motor mechanisms theory in 1890 (Silva, 1983), but a specific description of mental practice as an area of psychological inquiry begins with Washburn's publication of *Movement and Mental Imagery* in 1916 (Richardson, 1967). Washburn made two important assertions in his writings which formed the core of all subsequent research in the mental practice field.

Washburn's first assertion that mental practice of a motor task would produce small *tentative* movements of the muscles to be involved in performing the task was first proven by Jacobson (1932) and later confirmed by Shaw (1940). These researchers also discovered that this minute physical activity could be positively influenced by prior movement experience according to Jacobson, and by more vivid imagery according to Shaw.

Washburn's second assertion that the mental practice of a motor task would facilitate improvements in the subsequent overt performance of the task is the key on which the entire field turns. A study of the principle mental practice reviews such as Ammons (1958), Clark (1960), Smith and Harrison (1962), Richardson (1967), Corbin (1972), and Feltz and Landers (1983) shows that the majority of the literature supports Washburn's hypothetical improvement from mental practice, but a handful of studies may be found to dispute this central theme. It follows from this dichotomy in the literature
that certain problems remain unsolved in the determination of the efficacy of mental practice as a performance enhancing technique.

Although the literature identifies numerous variables which may effect the use of mental practice such as the sexual gender of subjects, intelligence, task experience, spatial relations ability of subjects, and others (which will be discussed in the literature review), the data does not always present a clear picture of how these variables effect the use of mental practice.

For instance, since undirected mental practice basically involves the construction of mental models of overt behavior and their spatial manipulation within the subject's imagination, a researcher might reasonably expect to find a relationship between mental practice and the subject's skill with spatial relations. However, a 1960 study by Wilson (Corbin, 1972) using the tennis forehand and backhand drives as the task, assessed the spatial relations abilities of subjects using the Spatial Relations test of the Differential Aptitude Series and found no significant relationship between this ability and the subject's improvement through mental practice.

The problem with this finding is that Wilson's subjects in the mental practice condition and the physical practice condition did not demonstrate any significant difference in subsequent performance when compared to subjects in the no practice condition. Since there was no significant effect from mental practice in the task which Wilson investigated, no meaningful conclusion can be drawn from the relationship between the subjects' spatial relations ability and their ability to use mental practice.

Another important problem faced by researchers trying to interpret the wealth of data on mental practice is the phenomenon of task specificity. The differential effects produced by mental practice are often so specific to a particular task that it is completely
improper to generalize the results to any other task. A methodology which produces
significant gains in the pursuit rotor task may not work at all with a mirror drawing task
and vice versa. For this reason, it is important for the researcher to choose a task which
has been well-represented in the literature so that a broad base of task specific
information is available for meaningful interpretation.

The restrictive ability to generalize results meaningfully across differing tasks has
also been addressed by the adoption of various task categories. The six most commonly
applied task categories are generally viewed as opposite ends of three task continuums:
simple versus complex, gross-motor versus fine-motor, and open versus closed. These task
continuums revolve around the degree of difficulty or type of cognitive content inherent in
the task (simple versus complex), the type and extent of the musculature involved in
performing the task (gross-motor versus fine-motor), and the role of environmental
variability during the performance of the task (open versus closed). The idea behind these
task categories is that a task can be identified as being predominantly of one type or the
other and, once categorized, the results obtained can be generalized appropriately to other
tasks within that category. These categorizations are extremely helpful when used
correctly but can occasionally lead to erroneous conclusions.

One illustration of the hazards involved in task categories is demonstrated by
Morrisett’s unpublished doctoral dissertation (1956) which is quoted in Corbin’s (1972)
review:

Morrisett suggested that all tasks require each of three basic skill
dimensions but that skills are predominantly either symbolic
(stimulus-response association), perceptual (stimulus discrimination), or
motor (high in skeletal muscular activity) . . . using tasks emphasizing each
of the three factors (symbolic, perceptual, motor). He concluded that
mental practice improved the performance of symbolic tasks and had little
influence on the performance of motor skills.
Morrisett's task categories have a great deal of face validity but cannot be taken too far as Kelsey's (1961) study demonstrates that mental practice is capable of increasing subsequent physical endurance in a predominantly motor task such as sit-ups, contradicting Morrisett's assumptions about motor tasks.

Given the many areas of confusion in the mental practice field, the present study has focused on two hypotheses: (a) mental practice will result in improved subsequent performance, and (b) the subjects' ability to mentally manipulate spatial relationships will covary with improvement through mental practice.

LITERATURE REVIEW

Washburn's original assertion in 1916 (Richardson, 1967) that the mental practice of a task would result in subsequent improved performance of the task was quickly complicated by the number of related variables which effect the use of mental practice and the differential improvement obtained based on the nature of the task to be practiced. A review of the literature follows with each study grouped according to the variable under investigation.

Sex

In 1939, Perry compared male versus female performance (Richardson, 1967) in mirror drawing and four other tasks using mental practice and found no significant differences in the amount of improvement between the sexes for any of the five tasks. The results of a Meta-analysis by Feitz and Landers (1983) which combined 60 mental practice studies also found no significant differences between the sexes in their ability to use mental practice.
Intelligence

Corbin cites five studies in his 1972 review which investigated the role of intelligence in the use of mental practice. Of these five Clark (1960), Start (1960), Whiteley (1962), and Oxendine (1968) found no significant relationship between mental practice and intelligence. Only Perry's (1939) study indicated that subjects with higher intelligence were more likely to benefit from mental practice.

Task Experience

Corbin's (1967a) investigation of the acquisition and retention of a wand-juggling task revealed no improvement based upon the use of mental practice. In an effort to resolve the discrepancies concerning the use of mental practice in the acquisition of motor skills, Corbin suggested that mental practice must be based upon task experience in order for the mental practice to be effective.

In his follow-up study, Corbin (1967b) required all subjects to experience or actually practice the juggling task under a controlled condition prior to mental practice. This controlled experience with the task resulted in improved performance through the use of mental practice and demonstrated an interaction between mental practice and prior task experience, particularly for relatively complex motor skills. This hypothesis is supported by Phipps' (1968) study of the interaction between mental practice and task difficulty (Corbin, 1972). Dividing his subjects into three task groups, which he classified as simple, intermediate, and complex difficulty, Phipps found that mental practice did not improve the performance of subjects in the complex task group without prior physical practice, although performance of simple tasks was improved without prior task experience. Phipps hypothesized that the need for mental practice to be based on task experience is more
acute for complex tasks because it is more difficult for the subject to grasp the nature of a complex task and know what to practice.

**Skill Level**

Clark (1960) studied the use of mental practice in developing the one-handed basketball shot and divided subjects according to skill level. The results indicated that the low skill group benefitted the most from the use of mental practice. Conversely, a study by Whiteley in 1962 indicated that the high skill group used mental practice more effectively (Corbin, 1972). Other studies appearing in the literature break down along similar lines. Most studies which look at the relationship between mental practice and skill level find a significant relationship, but no consensus appears across the board in terms of which skill levels, high versus low, will be most likely to benefit from mental practice on a given task.

**Motivation**

Hanson (1967) cited the common problem that earlier studies showed a tendency for the researcher to give subjects in mental practice conditions more attention than subjects in control conditions. Hanson suggested that the increases in motivation and arousal caused by this additional attention, sometimes dubbed the "Hawthorne effect," might be causing the performance increases which the studies ascribed to mental practice. Building on Hanson's hypothesis, Williams (1970) study utilized an Electromyogram (EMG) which measures the intrinsic electrical activity in muscles, and formulated an arousal index based on subjects' EMG responses. He concluded that the arousal state of the subject did not affect the use of mental practice (Corbin, 1972).
Practice Session Schedule and Length

Twining (1949) was one of the first investigators to study the effects upon mental practice of reactive inhibition, the excessive repetition of a task causing a work decrement in its subsequent performance (Feltz & Landers, 1983). His research suggested that five minutes is the upper limit for mental practice sessions, but a more recent investigation conducted by Shick (1969) found that the optimal length of practice sessions should be between one to three minutes, with the latter being superior in effectiveness (Corbin, 1972). Kohl and Roenker (1980) also found that work decrement was built up during mental practice to the same extent that work decrement built up during physical practice in the pursuit rotor task. Their data indicated that massed practice is not as effective in facilitating improvement through mental practice compared to a practice schedule which included interpolated rest periods allowing any possible work decrement to dissipate.

The three minute optimum proposed by Shick (1970) was also supported by the study of White, Ashton and Lewis (1979).

Type of Practice

Using direct observation as an alternative to undirected mental imagery, Siipola (1935) found that subjects who observed the mirror drawing task firsthand exhibited improved performance of the task when compared to subjects who had not been allowed prior observation.

Although the most common mental practice method in the literature is undirected mental imagery, different types of mental practice have emerged since Siipola's use of observation. For example, Brassie (1968) investigated a number of mental practice methods and found that observation of an overt performance was more effective than
verbal instruction, and that the least effective method of mental practice was overt verbalization by the subject (Corbin, 1972).

Spatial Relations Ability

The study conducted by Wilson (1960) is the only study appearing in the literature which attempts to relate the spatial relations abilities of subjects with their ability to improve task performance through the use of mental practice (Richardson, 1967). Since Wilson was not able to obtain a significant improvement through mental practice in her study it seems appropriate to take another look at the relationship between mental practice and spatial relations ability. The present study will look at this relationship using the Revised Minnesota Paper Form Board Test developed by Likert and Quasha (1948) to measure the spatial relations ability of subjects. The reliability coefficients of this test range from 0.85 to 0.92 and the documentation available for this test claims:

One of the impressive facts about the Minnesota Paper Form Board Test is the unusual amount of studies concerning its validity. These studies have shown rather consistently that the MPFB Test is one of the most valid tests of mechanical ability. It seems to measure particularly well those aspects of mechanical ability requiring the capacity to visualize and manipulate objects in space. Thus it usually proves to be one of the best tests in any attempt to predict performance in mechanical drawing and other similar activities.

TASK SELECTION

The present study investigates the effectiveness of mental practice upon the mirror drawing task. Mirror drawing has been a popular heuristic among mental practice researchers ever since Siipola's (1935) study which found that observational practice of the mirror drawing task resulted in improved performance. Siipola's results, together with Brassie's data indicating the superiority of undirected mental imagery as a practice technique, suggest a study which combines undirected mental imagery and mirror drawing.
Mirror drawing can be fitted into the task categories as a fine-motor, closed, and complex task. This categorization makes it an excellent subject for mental practice research since the literature indicates that fine-motor tasks are more likely to benefit from mental practice than gross-motor tasks, and closed, complex tasks appear similarly oriented toward significant performance improvements through the use of mental practice.

The coupling of mental practice and mirror drawing was investigated by Smyth (1975), whose results demonstrated significant gains in performance times for only one of her four mental practice groups. The performance gains of Smyth's subjects may have been greater had she allowed them to experience the task prior to the use of mental practice. Her procedure is in direct conflict with the research of Corbin (1967) and Phipps (1968) which clearly demonstrates the need for subjects to have task experience prior to mental practice.

Using subjects who report having had no prior experience with the mirror drawing task (100% naive), and exposing all subjects to the task for an equal amount of time, would control the problems associated with task experience.

The most common experimental design in the literature on mirror drawing (Smyth, 1975; Ross, 1951) has subjects complete one circuit of a star-shaped maze at each trial. The total time required to complete the star-shaped maze is recorded, as are the number of errors, and one error is counted for each time the subject touches or crosses the perimeter of the maze. While some studies track the final scores of total time and total errors separately (Smyth, 1975), it seems more appropriate to blend time and errors by subtracting one second from total time for each error (Ross, 1951) so that improvement scores of the subjects are not inflated by sloppy performance on one parameter, or inflated by slow performance on the other parameter.
One problem with either of the methods mentioned above involves task experience. If each subject's task experience is to be rigidly controlled because of its potential influence on subsequent performance, then the amount of time spent on task must be equal for each subject regardless of skill level. Subjects with low skill levels cannot be rewarded with the greater amount of time on a task which would be required if all subjects were to complete one circuit of the maze. The literature indicates that subject variability in the mirror drawing task is high, with low skill subjects taking as long as 400 seconds to complete one circuit of the maze and high skill subjects taking as little as 40 seconds for one circuit. If subjects are given three practice trials to familiarize themselves with the task, the methodology mentioned above could lead to a situation in which low skill subjects have had 20 minutes of task experience and high skill subjects having had only two minutes of task experience. Clearly this situation does not offer a sufficient control of task experience.

In order to establish control of task experience, the present study used a method which holds time constant at 80 seconds per trial for each subject and recorded the percentage of the maze completed rather than the time taken to complete the maze. This 80 second practice duration is within the one to three minute optimum length of practice sessions suggested earlier. Between each 80-second practice trial, an interpolated rest period of 40 seconds should relieve any possible work decrement build-up as suggested by Kohl and Roenker (1980). Since total time-per-circuit cannot be recorded, there must also be an adjustment in the means by which the error component is factored into the overall score. The present study has factored the subject's error component negatively into the subject's overall score by subtracting one second's worth of the subject's performance from his total performance. The value of one second's worth of each
subject's performance is the percentage of the maze completed per second. This figure, multiplied by the number of errors, was subtracted from the gross percentage of the maze completed to obtain the final performance score.

SUMMARY

It appears from this review that the problems which continue to arise in the field of mental practice are chiefly attributable to the lack of information on internal subject variables affecting the subject's ability to benefit from mental practice. Until these confounding variables are isolated and identified, conclusive findings as to the external effects of mental practice will remain illusive.

The present study seeks to clarify the relationship between mental practice and a subject's ability to mentally manipulate spatial relations.
CHAPTER II

METHODS

SUBJECTS

Forty-five volunteer college students were the subjects of this experiment. All subjects signed a consent form prior to participation and reported that they had no prior experience with the mirror drawing task (100% naive).

APPARATUS

The apparatus used in this experiment was a pen, a target diagram, a mirror drawing device, and the Minnesota Paper Form Board Test. The target diagram was a continuous track, one centimeter in width which forms a six pointed star having an outside diameter of 18.5 centimeters. The start, finish, and counter-clockwise direction were indicated by a one centimeter arrow and all targets were identical.

The mirror drawing device consisted of a base to hold the mirror and a visual occluder. All direct view of the target was prevented by the visual occluder, forcing reliance upon the mirror image for performance feedback.

PROCEDURE

All subjects were administered the Minnesota Paper Form Board Test (MPFBT) and ranked according to their performance on the MPFBT. The three subjects with the lowest scores were randomly assigned to one of three treatment conditions: no practice
(NP), mental practice (MP) and physical practice (PP). The three subjects with the next lowest scores were similarly assigned, moving up through the MPFBT rankings by groups of three so that the result was three groups of fifteen subjects arranged in a blocked random design based on the subjects' MPFBT scores.

After completing the MPFBT and being assigned to a treatment condition, subjects were shown the mirror drawing apparatus and received standardized verbal instruction in the mirror drawing task as follows:

Before you is the mirror drawing apparatus. Please adjust the visual occluder plate here so that you can see your hand only through the mirror when your hand is on the test paper.

Please put the tip of your pencil on the tip of the arrow inside the star maze. When I say "GO," you will draw a line around the inside of the maze as quickly and accurately as possible in the direction indicated by the arrow without lifting the pencil off the paper. You will have 80 seconds to complete the maze. If you are able to complete the maze within 80 seconds, please continue around as many times as possible until I say "STOP."

Any departure from the maze should be corrected by reentry as near as possible to the point of departure. One error will be counted for each time the pencil line touches or crosses the track's perimeter, and one second will be subtracted from your score for each error.

All three groups engaged in three physical practice trials prior to administration of the practice condition (pre-trials). The physical practice trials were limited to 80 seconds of mirror drawing with a forty second interpolated rest period during which the subject was occupied by reading a poetry text. Each subject in the NP, MP, and PP groups read one poem from a standardized list during each 40-second rest period.

Because of the high variability of performance in the mirror drawing task (Siipola, 1935) which is particularly evident on the first trial of naive subjects, the first trial (pre-trial 1) was not scored. The percentage of the maze completed and the number of errors were recorded for pre-trials 2 and 3. Subjects' scores were recorded using the formula (%
Completed) - [(% Completed/80) x Number of Errors]. This formula factors the error component negatively by subtracting the equivalent performance of one second from the percentage of the maze completed consonant with Ross's (1951) scoring criteria and the instructions given the subjects during the experiment. The mean of pre-trials 2 and 3 was computed and this pre-trial mean was used as the baseline measure of performance.

After the three pre-trials, the MP group engaged in six mental practice trials using the same trial duration and interpolated rest/reading period. The standardized verbal instruction given to the MP group was as follows:

The next time I say "GO," you will close your eyes and practice mirror drawing for 80 seconds only in your imagination without moving your arm or hand, so relax and sit back. I want you to imagine that you are using the mirror to draw the line around the star. Imagine that you see your hand in the mirror and feel it drawing the line. Each time you go around the star in your mind, imagine that the movements seem easier, that your hand moves more quickly and accurately in swift confident motions.

The PP group proceeded directly from the three pre-trials to six trials of physical practice training with the 40-second interpolated reading period. The NP group read poetry for 12 minutes which was equal to the time the MP and PP subjects spent in their respective practice conditions. The same poetry book was used for all three groups.

After all subjects completed the treatment condition requirements, they were post-tested on the apparatus with three physical practice trials of 80 seconds (post-trials) and the interpolated 40-second reading period from the standardized list. Scores for the post-tests were tabulated for each subject on the same basis as the physical practice pre-tests, and the post-test mean was computed based on an average of all three post-tests.

Each subject was debriefed on the design and hypothesis of the experiment before leaving the test room. After the data was analyzed, the results were made available to subjects upon request.
CHAPTER III

RESULTS

The pre-trial mean was subtracted from the post-trial mean to obtain the improvement score. The improvement scores for the NP, MP, and PP groups were 0.97, 0.90, and 1.24, respectively. A breakdown of the means by trial and treatment condition appears in Table I.

For the purpose of analysis, the MPFBT scores were blocked according to the lowest five scores, the middle five scores, and the highest five scores within each practice condition. This blocking allowed a three factor analysis of variance to be used to compare MPFBT scores (low, medium, high), practice conditions (NP, MP, PP), and pre-trial means versus post-trial means. The improvement between pre-trial means and post-trial means was significant at the 0.001 alpha level and task performance differed at the 0.05 alpha level between the three MPFBT blocks (low, medium, high). There was a tendency for task performance to differ according to the practice condition and this tendency had a weak interaction with the effect of trials, but no interaction was exhibited between MPFBT blocks and the trials or practice conditions. The results of the three factor ANOVA appear in Table II.

A Spearman's rank-order correlation test also found no significant correlation between the subjects' MPFBT scores and their improvement scores at the 0.05 alpha level. The Rho values obtained are shown in Table III. The performance means were established for each MPFBT block by combining the performance scores across practice
### TABLE I

**MEAN SCORE AND MEAN IMPROVEMENT BETWEEN TRIALS BY TRIAL AND CONDITION**

<table>
<thead>
<tr>
<th>Trial Number</th>
<th>Mean NP Score</th>
<th>Mean MP Score</th>
<th>Mean PP Score</th>
<th>Mean Improvement</th>
</tr>
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<tbody>
<tr>
<td>Pre-Trial 2</td>
<td>1.03</td>
<td>1.48</td>
<td>1.45</td>
<td>N/A</td>
</tr>
<tr>
<td>Pre-Trial 3</td>
<td>1.34</td>
<td>1.72</td>
<td>1.85</td>
<td>0.40</td>
</tr>
<tr>
<td>Post-Trial 1</td>
<td>1.98</td>
<td>2.43</td>
<td>2.75</td>
<td>0.90</td>
</tr>
<tr>
<td>Post-Trial 2</td>
<td>2.16</td>
<td>2.55</td>
<td>2.79</td>
<td>0.04</td>
</tr>
<tr>
<td>Post-Trial 3</td>
<td>2.32</td>
<td>2.51</td>
<td>3.14</td>
<td>0.35</td>
</tr>
<tr>
<td>Pre-Trial Mean</td>
<td>1.18</td>
<td>1.60</td>
<td>1.65</td>
<td>N/A</td>
</tr>
<tr>
<td>Post-Trial Mean</td>
<td>2.15</td>
<td>2.50</td>
<td>2.89</td>
<td>1.24</td>
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</table>
### TABLE II

**ANALYSIS OF VARIANCE BETWEEN THREE FACTORS MPFBT (HIGH, MEDIUM, AND LOW), PRACTICE CONDITIONS (NP, MF, PP), AND TASK TRIALS (PRE-TRIAL MEANS VERSUS POST-TRIAL MEANS)**

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>DF</th>
<th>MS</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>10.40</td>
<td>89</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Between Subjects</td>
<td>75.69</td>
<td>44</td>
<td>---</td>
<td>---</td>
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<tr>
<td>MPFBT</td>
<td>9.59</td>
<td>2</td>
<td>4.80</td>
<td>3.20</td>
<td>&lt;0.05</td>
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<td>Practice Conditions</td>
<td>5.58</td>
<td>2</td>
<td>2.79</td>
<td>1.86</td>
<td>&lt;0.20</td>
</tr>
<tr>
<td>MPFBT x Practice</td>
<td>6.52</td>
<td>4</td>
<td>1.63</td>
<td>1.09</td>
<td>---</td>
</tr>
<tr>
<td>Within Subjects</td>
<td>29.29</td>
<td>45</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Trials</td>
<td>24.14</td>
<td>1</td>
<td>24.14</td>
<td>201.17</td>
<td>&lt;0.001</td>
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<tr>
<td>Trials x MPFBT</td>
<td>0.014</td>
<td>2</td>
<td>0.007</td>
<td>&lt;1</td>
<td>---</td>
</tr>
<tr>
<td>Trials x Practice</td>
<td>0.51</td>
<td>2</td>
<td>0.25</td>
<td>2.08</td>
<td>&lt;0.20</td>
</tr>
<tr>
<td>TR x PR x MPF</td>
<td>0.32</td>
<td>4</td>
<td>0.08</td>
<td>&lt;1</td>
<td>---</td>
</tr>
</tbody>
</table>
TABLE III

SPEARMAN’S RANK-ORDER CORRELATION OF SUBJECTS’ MPFBT AND MEAN IMPROVEMENT SCORES

<table>
<thead>
<tr>
<th>Condition</th>
<th>RHO</th>
<th>T-Value</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>NP</td>
<td>-0.02</td>
<td>-0.07</td>
<td>&gt;.05</td>
</tr>
<tr>
<td>MP</td>
<td>0.10</td>
<td>0.36</td>
<td>&gt;.05</td>
</tr>
<tr>
<td>PP</td>
<td>-0.10</td>
<td>-0.36</td>
<td>&gt;.05</td>
</tr>
</tbody>
</table>

conditions and trials. The means for the low, medium, and high MPFBT blocks were 1.54, 2.22, and 2.23, respectively.

It seems possible that the ranking of the pre-trial means appearing in Table I which existed prior to the administration of the practice conditions may have obscured the results. To address this question an analysis of variance was computed for the pre-trial means of the three groups producing an F ratio of 1.375 which was not significant at or above the 0.20 alpha level. The results of this ANOVA appear in Table IV.
TABLE IV
ANALYSIS OF VARIANCE BETWEEN THREE GROUPS OF PRE-TRIAL MEANS

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>DF</th>
<th>MS</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>32.22</td>
<td>44</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Between Practice Groups</td>
<td>1.97</td>
<td>2</td>
<td>0.99</td>
<td>1.375</td>
<td>&gt;0.20</td>
</tr>
<tr>
<td>Within Practice Groups</td>
<td>30.25</td>
<td>42</td>
<td>0.72</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>
CHAPTER IV

DISCUSSION

The results of this study support neither the first hypothesis (mental practice will result in improved subsequent performance) nor the second (the subject’s ability to mentally manipulate spatial relationships will covary with improvement through mental practice), and no increase in performance was achieved by subjects in the MP condition to demonstrate the superiority of mental practice over no practice. The mean improvement of the NP condition was actually higher than the improvement shown by the MP condition (see Table I).

This ranking of the MP group below the NP group is clearly at odds with the majority of the MP literature and may be the result of a work decrement buildup in both the MP and PP groups. Alternatively, the complexity of the mirror drawing task may require more than the three 80-second pre-trials in order for the subjects to gain sufficient task experience to benefit from mental practice. Corbin (1967a) noted that task experience can be an important factor in MP learning, and Phipps (1968) found the subject’s task experience is essential for complex tasks in comparison to simple tasks. This problem could be overcome by future researchers through an increase in the number of pre-trials and/or an increase in the duration of each trial. If the practice trials were also longer this would give the mental practice group more time, bringing the practice time closer to the three minute optimum suggested by Shick (1969). Another consideration would be the inclusion of a five minute rest period for the MP and PP groups between
the administration of the practice condition and the post-test to allow for the complete
dissipation of any work decrement buildup.

In the present study, the within group variance was simply too high to allow the
between group variance to emerge clearly from the data. With such a high degree of task
variability, two additional measures should be taken by any subsequent research to make
this design more effective. Increasing the number of subjects and controlling the skill
level of subjects should dampen the within group variability. The skill level of subjects
might be controlled by using only subjects whose pre-trial scores fall within one-half of a
standard deviation above or below the mean, or by ranking subjects according to their skill
level and making skill level another variable of the investigation.

Increasing the number or duration of the practice trials would allow more time for
the differential effects of the treatment conditions to become evident. In order to
lengthen the training time without moving closer to the learning curve peak, the use of
Ross's (1951) method in which subjects used alternating hands results in a more extended
learning curve.

The second hypothesis (the subject's ability to mentally manipulate spatial
relationships will covary with improvement through mental practice) was not supported by
the data either. The low rho scores in Table III show that the ability to mentally
manipulate spatial relationships did not covary significantly (alpha > 0.05) with the
subject's improvement scores in any of the three groups. Implicit in the second hypothesis
is the idea that the ability to manipulate spatial relationships is so intimately related to the
process of mental practice that the relationship will emerge even if the relationship
between spatial manipulation abilities and the task under investigation is very weak. The
data demonstrates the exact opposite, however. The significant differences between the
low, medium, and high MPFBT blocks (see Table II) show that the MPFB test did measure a task related variable. The ranking of the MPFBT block means indicates a tendency for the MPFB test to predict skill level for the mirror drawing task.

Given this potential relationship between spatial abilities and mirror drawing, it seems even more interesting that a test which may predict a skill required for a task will not also predict learning through mental practice. Unfortunately, the present study cannot make a definite conclusion on this point because no mental practice effects were in evidence.

In conclusion, the results of this study do not support either of the hypotheses which initiated this work, but there are some interesting indications. The lack of statistical support for the efficacy of mental practice which puts this work at odds with the majority of the literature on mental practice is probably the result of the particular methodology employed in this study and might be corrected by the remedies proposed.
REFERENCES


